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UNITED STATES DEPARTMENT OF AGRICULTURE

DEPARTMENT BULLETIN No. 1167

Washington, D. C. ▼ August, 1923

CULTIVATION OF THE TRUE YAMS IN THE GULF REGION.

By ROBERT A. YOUNG, *Plant Introducer, Office of Foreign Seed and Plant Introduction, Bureau of Plant Industry.*

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WHAT THE TRUE YAMS ARE.

The true yams belong to the genus Dioscorea, which includes some 250 species of climbing vines with underground tubers. The edible species of yams produce starchy tubers similar to the white (Irish) potato in food value and taste; many varieties are equal or superior to the best white potatoes. The name "yam," as used for these plants, should not be confused with the name applied to certain moist varieties of sweet potato (*Ipomoea batatas*). True yams and sweet potatoes are unrelated botanically and, although the plants of both are vines and produce underground tubers or tuberous roots, neither the vines nor the tubers of the two groups bear a real resemblance to each other.

ECONOMIC IMPORTANCE OF THE TRUE YAMS.

Not all of the yams produce edible tubers, but of the edible species a few are of great economic importance. Yams form a considerable part of the food supply of the peoples of many humid tropical regions,[1] and they are used to a limited extent outside of the Tropics, more especially in China and Japan. It seems remarkable that a vegetable of such merit should not long ago have received more serious attention from Americans.

[1] Fairchild, David G. Yams in the West Indies, Circular No. 21, Div. of Botany, U. S. Dept. of Agr., 1899. A brief account of yam culture in Jamaica and Barbados.

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In this country New York and a few other cities having a large West Indian population demand considerable quantities of the true yams. Previous to 1918 this demand was supplied by shipments from outside the continental United States; but since that time, when the importation was prohibited,[2] because of the danger of introducing or further spreading in the sweet-potato regions of the country certain insect pests [3] common to sweet potatoes and the true yams, such supply as there has been has come from Florida.

OPPORTUNITY FOR A YAM INDUSTRY IN THE SOUTH.

With a market for yams already established and the fact demonstrated that the crop can be successfully grown in Florida and in the coast regions of other Southern States, an unusual opportunity seems to present itself for the development of a new crop industry in some of the South Atlantic and Gulf States. The present limited market may be expected to grow larger as more of our people come to realize the excellence of the yams as food.

GENERAL DESCRIPTION OF THE TRUE YAMS.

The vines of the true yams, unlike those of the sweet potato, are climbing and twining. The leaves are parallel veined and those of nearly all of the edible species are more or less heart shaped, though a few are divided or deeply lobed. In food characteristics the yams are much like the white, or Irish, potato. Most yams are white fleshed, while a few are yellow or purple. Some are noticeably sweet, but these bear less resemblance to the sweet potato than to the white potato.

While yams produce underground tubers (Pl. I), some also bear aerial tubers in the leaf axils (Pl. II, Fig. 2). There are edible kinds that bear their main crop in this way, though they are not so highly esteemed for food as are most of those that produce the crop under ground.

KINDS OF YAMS.

In the West Indies, whence most of the introductions of yams by the Department of Agriculture have been made, several species [4] are regularly cultivated. The principal ones are the following: *Dioscorea alata* L., the greater yam; *D. cayenensis* Lam., the yellow Guinea yam; *D. esculenta* (Lour.) Burkill, the lesser yam; *D. latifolia* Benth., the acom; *D. rotundata* Poir., the white Guinea yam; and *D. trifida* L. f., the yampi.

The purpose of the present paper is primarily a consideration of the greater yam (*Dioscorea alata* L.) as a new crop industry for this country; but since varieties of the other species are being tested with a view to their possible commercial cultivation, brief notes concerning these species are included.

The yellow Guinea yam (*Dioscorea cayenensis* Lam.) as grown in the West Indies is an attractive yellow-fleshed yam of good quality,

[2] Quarantines Nos. 29 and 30, U. S. Department of Agriculture, Dec. 17, 1917. Effective Jan. 1, 1918.

[3] The sweet-potato weevils, *Cylas* spp., and the sweet-potato scarabee, *Euscepes batatae*.

[4] For the specific identifications upon which this statement is based the writer is indebted to I. Henry Burkill, director of the Singapore Botanic Gardens, who, in collaboration with Sir David Prain (formerly director of the Royal Botanic Gardens, Kew, England) has made careful studies in the genus Dioscorea. Some of the common names given in this paper are also used at the suggestion of Mr. Burkill.

except for a more or less bitter taste. It is very popular among the West Indians. In Porto Rico it is also known as the Congo or Congo amarillo, and in Jamaica as the yellow, or affou, yam. The tubers (Pl. III, Fig. 1) often reach a weight of several pounds each. They do not keep very well. The vine is round, glossy dark green, and thorny, with alternate leaves. In the Tropics this species requires about 12 months to mature.

The lesser yam (*Dioscorea esculenta* (Lour.) Burkill), including many varieties, usually produces rather small oval tubers (many in a hill), weighing from less than a pound to nearly 2 pounds each. They generally keep well. The skin is thin, tough, and usually smooth (Pl. II, Fig. 1), and in some varieties the tubers are covered with hairy roots. The plants have underground thorny stems near the surface of the soil which, though they increase the difficulty of harvesting the crop, also serve to protect the tubers from the depredations of animals.

In general, the lesser yam requires a rich, loamy soil. Snowy whiteness and more or less sweetness of the flesh when cooked characterize the best varieties. The flesh is very mealy, though in some varieties there is at times considerable fiber. The vine is round and bears a variable number of short spines between the leaves, with a pair of somewhat longer ones at each leaf. The leaves are broadly heart-shaped and alternate.

The acom (*Dioscorea latifolia* Benth.) bears its crop of tubers aboveground in the axils of the leaves. These aerial tubers (Pl. II, Fig. 2) are angular and have a greenish gray skin; the largest reach a weight of nearly a pound. The flesh is dull yellow and rather dry; when cooked it is very firm and of fair flavor. Acom tubers are remarkable for their keeping qualities. The vine is round and spineless, and the leaves are broadly heart-shaped and alternate. Various local names, having such meanings as "turkey-liver yam," "climbing air potato," and "Carib potato," are in use in different parts of tropical America.

The white Guinea yam (*Dioscorea rotundata* Poir.)[5] is grown in Porto Rico under the name of Guinea yam (Pl. IV, Fig. 1). In Jamaica and some other localities it is known as the negro yam. It is white fleshed and is one of the best and most popular yams cultivated in the West Indies. In Porto Rico this yam grows best in clayey soils. It matures in a shorter season[6] than other yams. The tubers weigh up to 6 pounds each. The glaucous vine is round and armed on the older parts with short but strong recurved thorns. The leaves are opposite. Many forms[7] of this species are reported to exist in Africa, its native home, but only one appears to be known in the West Indies.

The yampi (*Dioscorea trifida* L. f.) exists in several distinct varieties. The Jamaica yampi (Pl. III, Fig. 2) is one of the best known. A variety grown in Trinidad is known locally as cush-cush. The tubers of the different types of yampi vary in size, form, and color

[5] Burkill, I. H. The correct botanic names for the white and the yellow Guinea yams. *In* Gardens' Bul. Straits Settlements, v. 2, p. 438. 1921.

[6] Kinman, C. F. Yam culture in Porto Rico. Porto Rico Agr. Exp. Sta. Bul. 27, p. 12. 1921.

[7] Burkill, I. H. Some cultivated yams from Africa and elsewhere. *In* Gardens' Bul. Straits Settlement, v. 2, p. 87. 1918.

of flesh; the inner skin is commonly reddish or purple, and the flesh is white, pink, or purple. Most yampis are of excellent quality. The vine is angular and usually 2-winged. The leaves are prominently 3-lobed. Plants of this species are not very strong growers.

THE GREATER, OR TEN-MONTHS, YAM.

DESCRIPTION OF THE PLANT.

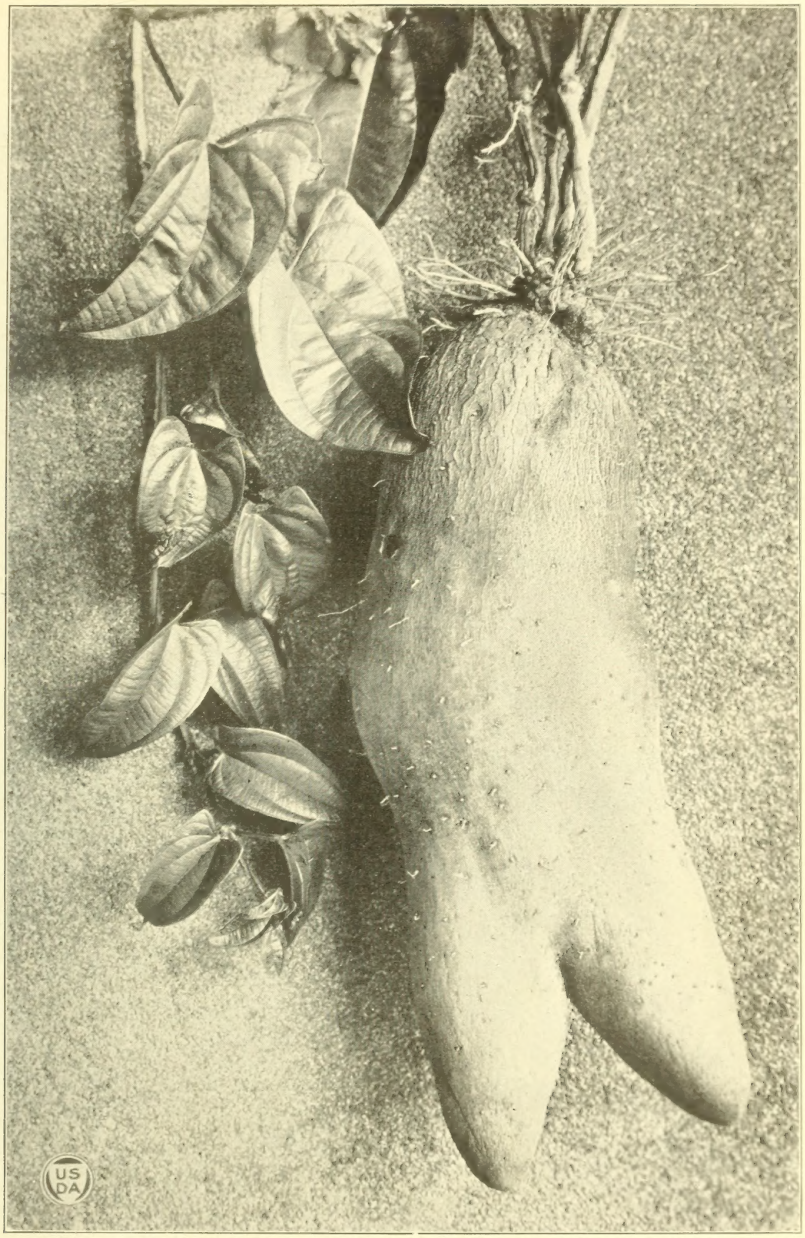
The vine of the greater yam, *Dioscorea alata*, is 4-angled and has heart-shaped opposite leaves (Pl. I). As the specific name *alata* suggests, the stem is often winged (alate) at the angles; it is without thorns or spines. In general, the flesh of the tubers is white and the inner skin white or merely yellowish. There are varieties, however, with yellowish flesh; others have white flesh and reddish or purple inner skin, and some even have light or deep purple flesh. The quality ranges from inferior to excellent, according to variety. The starch granules average rather large, having about the same range in size as those of the white potato, but with the smaller granules fewer in number; they are often somewhat triangular in outline, as viewed under the microscope, instead of being always oval or round as in the potato.

The tubers of the largest varieties sometimes attain great size, 100 pounds or more, especially when the climatic conditions are such as to permit growth without serious interruption for a season greater than the normal length. The greater yam is the most important as well as the most widely distributed of the six species which have been mentioned. It is this yam that has been most widely tested in the southern United States and which has thus far shown the greatest adaptability for cultivation in Florida and other sections of the South Atlantic and Gulf regions. Besides producing larger tubers than the other yams, this species exists in a greater number of varieties. Although a long season, 8 to 10 months, is required for the development of a good crop, yet in one or another of its varieties the greater yam is adapted to a rather wide range of cultural conditions. It is believed that in favorable situations some varieties can be successfully grown, at least for home use, in the coast regions from Galveston, Tex., to Charleston, S. C., and possibly in parts of southern California.

HISTORY OF THE INTRODUCTION.

Two or three varieties of the greater yam have been successfully cultivated on a small scale by a few persons in southern Florida for many years, though no data are available to show when they were introduced. However, the following extract from a letter written to the Department of Agriculture by J. DeHoff, Arch Creek, Fla., March 23, 1913, indicates the successful introduction of one of them not much later than the middle of the last century:

> I got one seed bulb in 1893, when I first came to Avon Park, De Soto County, Fla., from a neighbor, H. G. Burnett, who had a few in his garden. He got them from his father-in-law at Fort Myers, where they have been grown, I understand, for 50 years, though not in large quantity. I have kept seed from year to year since that time (no more, though, than I wanted myself) until year before last, when somehow they made several times more seed bulbs than I ever saw before. This last year they again made only a very few



TUBER OF A VARIETY OF THE GREATER YAM (DIOSCOREA ALATA L.) WITH A SHORT SECTION OF VINE ATTACHED.

This tuber weighs 3½ pounds. This yam is grown for home use and in a small way for market by a number of people in the South Atlantic and Gulf regions. Many varieties when properly prepared for the table are equal or superior to the best white potatoes. (P26648FS.)

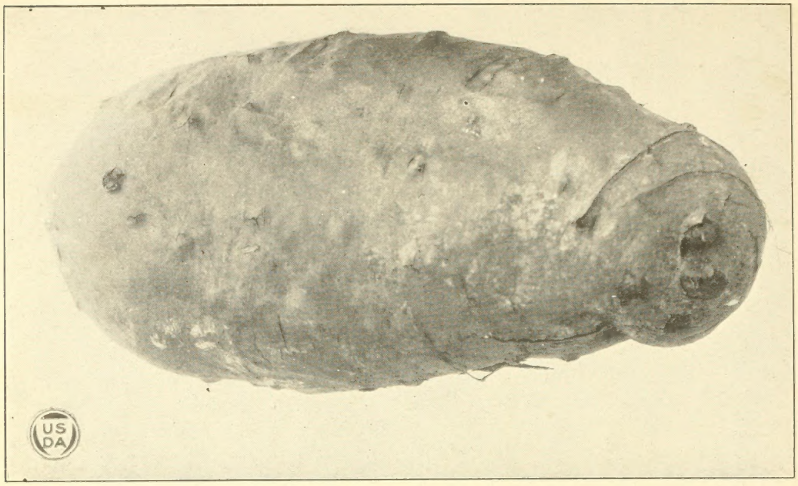


FIG. 1.—TUBER OF A VARIETY OF THE LESSER YAM (DIOSCOREA ESCULENTA (LOUR.) BURKILL).

The skin of the tubers of this species resembles that of the white potato, but is much tougher. The flesh is snowy white, mealy, and usually slightly sweet. (P27118FS; natural size.)

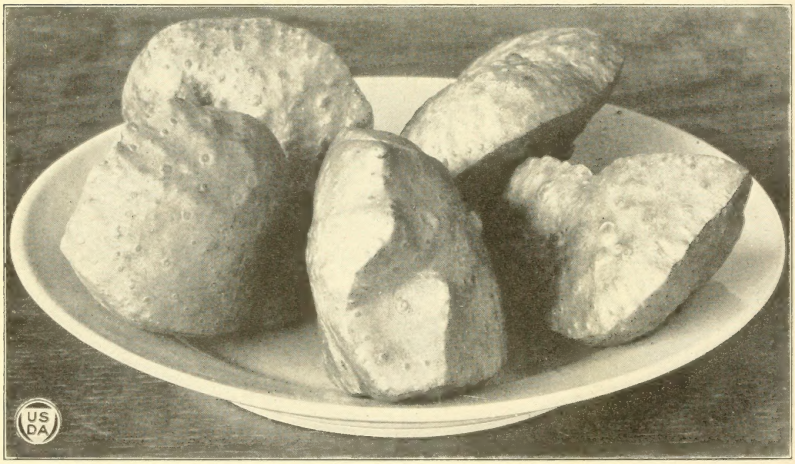


FIG. 2.—TUBERS OF THE ACOM (DIOSCOREA LATIFOLIA BENTH.) FROM BRAZIL.

This species of yam, under various local names, is grown in different parts of tropical America and in the Old World Tropics. The crop is borne aboveground in the axils of the leaves. The specimens shown above weigh 4 to 6 ounces each. (P25411FS.)

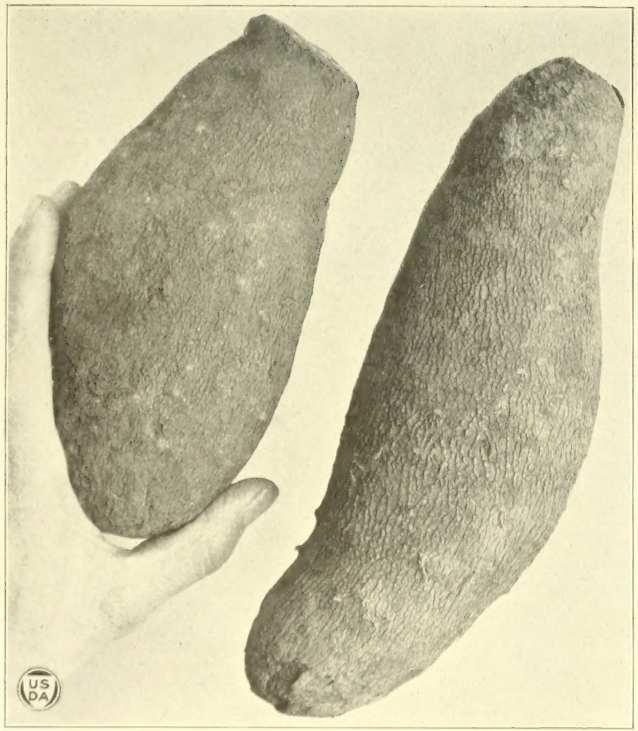


FIG. 1.—TUBERS OF THE YELLOW YAM (DIOSCOREA CAYENENSIS LAM.), RECEIVED FROM THE WEST INDIES.

This yam is somewhat bitter, but otherwise of fair quality, and the flesh has an attractive yellow color. Other names for this yam are yellow Guinea, Congo, and affou. In the Tropics it requires about 12 months to complete its growth. (P27219FS.)

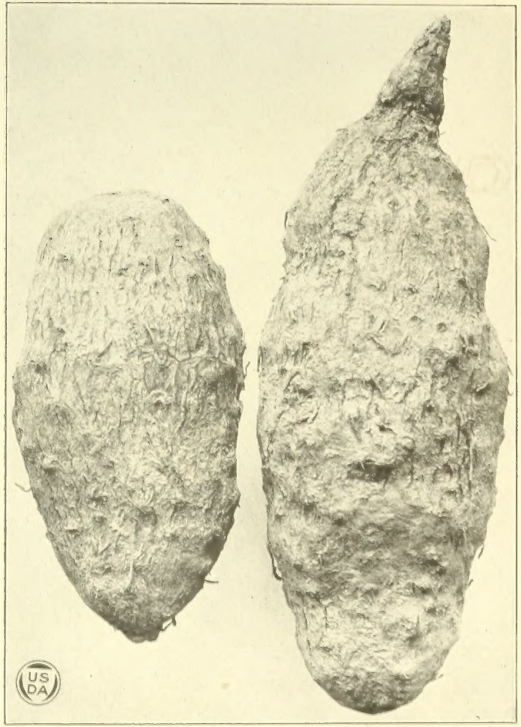


FIG. 2.—SMALL TUBERS OF THE JAMAICA YAMPI (DIOSCOREA TRIFIDA L. F.).

A different variety of the yampi in Trinidad is called cush-cush. Most of the varieties of this species are of excellent quality. (P7853FS.)

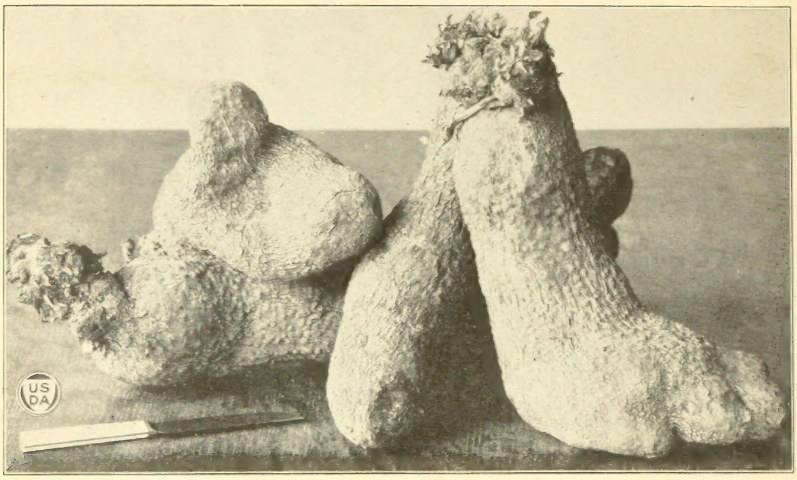


FIG. 1.—TUBERS OF THE WHITE GUINEA, OR NEGRO, YAM (DIOSCOREA ROTUNDATA POIR.).

This is one of the best yams for home use and market grown in Porto Rico. The tubers shown above, received from Porto Rico, range from 2½ to 4 pounds each in weight. (P23774FS.)

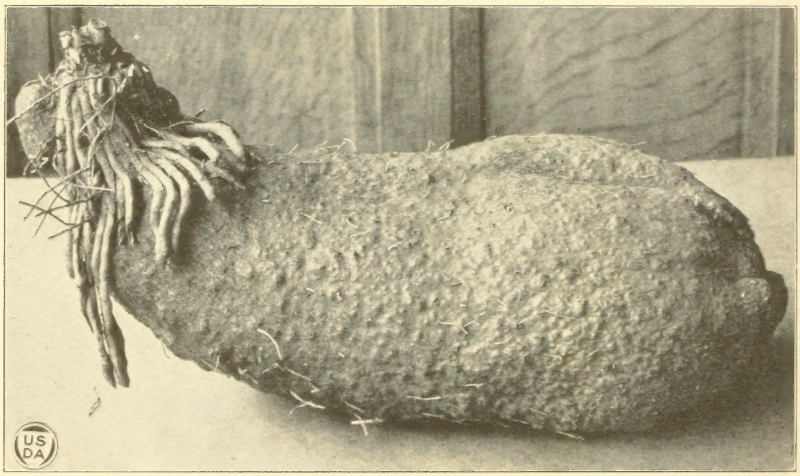


FIG. 2.—A 10½-POUND TUBER OF THE GREATER YAM (DIOSCOREA ALATA L.), S. P. I. NO. 47001, GROWN IN CENTRAL FLORIDA.

(P26827FS.)

seed bulbs. I received the yam under the name of White Jamaica, but do not know whether this name is correct. Mr. Burnett, who was quite a horticulturist, said the botanical name was *Dioscorea alata*. I grew the yams for five years near Palatka (at Florahome) and they did well on high hammock land. Down here in Dade County on very light sandy and rocky land they produce as much as sweet potatoes and with me take the place of Irish potatoes; the latter will not succeed on this dry soil at all. The yams keep for months.

Tubers of the yam referred to in the foregoing letter were sent to the Department of Agriculture early in 1913 from Santa Rosa, Fla., by a cooperator who had previously obtained the variety from Mr. DeHoff. These were recorded under seed and plant introduction (S. P. I.) No. 37943. The species is *Dioscorea alata*, as stated in Mr. DeHoff's letter. The same variety (S. P. I. No. 49496) was later obtained by the department from O. P. Wernicke, of Brooksville, Fla., who brought it from Avon Park, Fla., and still more recently (S. P. I. No. 52927) from Mr. DeHoff himself.

Introductions of other varieties of yams from the Orient and the West Indies have been made by the Office of Foreign Seed and Plant Introduction at various times during the last 25 years and distributed to interested plant experimenters. However, on account of the lack of definite knowledge by farmers concerning the crop and its requirements and the absence of the stimulus of a market demand these introductions have been largely without results.

So far as known the first shipment of Florida-grown yams to a northern market was of the variety described by Mr. DeHoff, grown by O. P. Wernicke in 1918. Since 1918 there has been an insistent demand for the vegetable in the New York market, but the more rapid development of the industry has been prevented by the limited quantities of propagating material available and the unfamiliarity of farmers with the yam as a commercial crop. At the present time small commercial quantities of yams are being raised by a few farmers in the South, and about 400 persons are growing them experimentally and for home use.

GROWING THE GREATER YAM.

WHEN TO PLANT.

Yams are often slow to begin growth in the spring, but it is found best when practicable to plant in southern Florida soon after the first of March. Planting as late as April 1 is sometimes satisfactory, however, and in northern Florida it may even be delayed until the last of April when necessary. The greater yam has been called the ten-months yam, but some varieties of it have produced fairly good tubers in eight to nine months.

SEED TUBERS.

Some varieties of the greater yam have a strong tendency at times to produce aerial tubers in the axils of the leaves, especially when the vines run on the ground. The development of this tendency in Florida often varies from year to year, perhaps because of differences in weather conditions. These tubers as well as those borne underground are used for propagation; but plants from very small aerial tubers produce rather small underground tubers the first year.

The crowns of the underground tubers should generally be reserved for planting. Because of a hard texture and often some discoloration of the flesh this part of the tuber is likely to be scarcely edible, and furthermore the crowns ordinarily sprout a little sooner than cuttings from other parts. Any part of the yam tuber may be used satisfactorily for propagation, however, and under similar conditions little difference in yield is to be expected between plants propagated from different parts of the tuber. Tubers may be cut into pieces weighing from a few ounces to a pound each, depending upon the size of the tuber.

It is advisable to dry the freshly cut surfaces in the sun for a few hours before planting. Some growers and handlers favor dusting the cut surfaces with air-slaked lime or even with fine wood ashes before drying. At the Porto Rico Agricultural Experiment Station[8] the application of Bordeaux mixture to the freshly cut surfaces gave better results than any other treatment. Experiments made at the Plant Introduction Garden, Brooksville, Fla., have shown the simple sun drying to be satisfactory there.

Depending upon the variety and also upon the size and character of the tuber or piece of tuber planted, one to several yams are produced in a hill. A piece weighing half a pound or more unless it already has a well-developed single sprout will often sprout at two or more points (Pl. V, Fig. 1) and each of the resulting plants will produce a tuber. A much smaller piece usually develops but one sprout and one tuber. Great size of individual tubers does not result when there are more than one in a hill. The size to which yam tubers grow is further influenced by the distance apart of the plants and the fertility of the soil, as well as by length of season and weather conditions.

WHERE AND HOW TO PLANT.

Most varieties of the greater yam do better in a deep, mellow, somewhat sandy loam than in heavy clay soils; some have also done well in properly drained muck. The tubers are planted 2 to 3 inches deep. To obtain the best results trenches (Pl. VI) or holes 18 inches deep and 18 inches or more in width filled with loose soil and decaying vegetable matter or well-rotted manure should be prepared, or ridges composed in part of such material may be thrown up. The width of holes or trenches is generally made about half the distance between the rows. For hole planting, 3 by 3 feet apart is good spacing, but this may be varied somewhat and the holes made oblong instead of round if desired. In trench planting, 3½-foot rows with the plants 15 to 18 inches apart in the row are recommended.[9] Greater distances apart in rich soil may give larger tubers but smaller acre yields.

If undecayed vegetable matter is used it should be mixed with the soil several weeks before planting time. The idea is to provide a bed of loose, rich soil in which the rather large tubers may develop freely. A compact soil tends to produce misshapen tubers.

[8] Kinman, C. F. Yam culture in Porto Rico. Porto Rico Agr. Exp. Sta. Bul. 27, p. 7. 1921.

[9] The best distances for planting yams will vary slightly according to the variety and the soil conditions, but the distances specified will be found generally satisfactory. In the West Indies the distances recommended are approximately the same as those above. (See Rpt. Agr. Dept. Grenada, 1920, p. 4. 1921.)

Because of the sandy character of most soils where yams have been grown in Florida, it has been possible sometimes to raise fairly good crops without such preparation of the soil as advised in the foregoing, but in these instances the soil conditions have been favorable and commercial fertilizers have been used. Experiments reported by investigators in the West Indies indicate that it pays well there to have the land fully prepared.

Where it is wholly impracticable to supply the additional humus and prepare the land as directed, two applications of a complete commercial fertilizer will usually make it possible to raise a yam crop. The first application should be given shortly after the plants are up and the second may be given six to eight weeks later. A good formula for sandy soil is about 6 per cent ammonia, 6 per cent phosphoric acid, and 8 to 10 per cent potash. Each application of fertilizer may be at the rate of 2 to 2½ ounces per plant.

HOW TO INFLUENCE THE SIZE OF TUBERS.

Mention has been made of the large size to which the greater yam may grow. Some remarkable records have been made in Florida. Single tubers of 50 to 60 pounds' weight have been produced at the United States Plant Introduction Garden at Miami. From Sebring has been received an authentic report with a photograph of a 63-pound yam grown in a season of 11 months. There is also reliable testimony of the harvesting a few years ago at Crescent City of a single yam tuber of three years' growth which weighed 137 pounds. The quality of all of these large yams was reported to be quite equal to that of smaller tubers of the same varieties.

Very large yams are often misshapen—lobed, branched, or "fingered"—and naturally are much less easily harvested, handled, and marketed than smaller ones of better shape. Growers of the greater yam will usually prefer tubers between 3 and 8 pounds in weight. Tubers within these limits when of even form and reasonably smooth surface are especially desirable for market. The size of the tubers may be controlled to some extent by modification of the planting distance. To keep down the size of individual tubers, two or three pieces of tuber may be planted in a hill if there is reason to expect only one sprout from each piece.

According to a report [10] of experiments in Trinidad, an increasingly large proportion of tubers of regular shape can be raised by continuously selecting such shapes for planting. The well-shaped tubers were in general much smaller than the others, however, and it became necessary after reducing the number of ill-formed ones in the crop to begin selection for increased size as well as good form. Experiments are under way in Florida to determine what results may be secured there by selection.

SUPPORTS FOR THE VINES.

Yam vines should be furnished with tall stakes, a trellis, or some other support upon which to run, when practicable. (Pl. VII, Figs. 1 and 2.) In the experience of the department this insures a greater yield than can be obtained from unsupported vines. Be-

[10] Brunton, L. A. Selection in the shape of yams. *In* Proc. Agr. Soc. Trinidad and Tobago, v. 21, p. 116–118. 1921.

cause of the labor and other costs involved in providing supports, growers quite frequently omit them (Pl. VIII), but it is believed always at the expense of yield. In Florida a particular disadvantage in growing yams on clean-cultivated ground without supports is that in the early part of the season the tips of the vines are injured by the heat of the surface soil. Reports of experiments in the West Indies nearly all indicate that staking the vines pays in increased yields. Nearly double the rate for unstaked vines has at times been obtained by staking. The results of experiments in Florida confirm those obtained elsewhere.

YAMS AS ORNAMENTALS.

As a screen for a porch (Pl. IX, Fig. 1) or an outbuilding the yam is a useful ornamental. The vine grows rapidly in a reasonably fertile soil, and if sufficient moisture is supplied a prolific growth of very attractive foliage is secured. Where the season is of seven or eight months' duration a fair-sized tuber may be expected from each plant by the time the vine is finally killed by frost. But vigorous vine growth may be obtained where the frostless season is much shorter, and the use of the yam as a screen or shade alone under such conditions is well worth while.

COST OF GROWING YAMS.

On account of the deep preparation of the soil required for the best results in the field cultivation of yams, the need of the vines for support, and the labor and care necessary in the proper harvesting, curing, and packing of the tubers for shipment, the cost per pound to the producer must be greater than for the commoner root crops. However, the people accustomed to use yams show a willingness to pay the necessary price, just as in times of potato scarcity people will pay a very high price for this usually moderate-priced vegetable. Besides this, the better varieties of yams possess such merit that it may fairly be assumed that many fancy markets now unfamiliar with the yam will gradually come to demand it as they become acquainted with it.

HANDLING THE YAM CROP.

HARVESTING AND STORING.

Yams may be harvested about the time of the first killing frost, or some time later if succeeding frosts are not so severe as to endanger the tubers in the ground by freezing. Digging should be done with spade or shovel in bright, warm weather in order to permit the tubers to dry well before being stored or shipped. It is preferable to dry the freshly dug yams in the shade rather than to expose them to the direct sunlight.

The tubers must be handled carefully, especially in digging and immediately thereafter, since they are then exceedingly tender and brittle, and bruise or break very easily. Any bruised or cut surface should be dried quickly in the sun, and if the weather is cool or damp at time of harvest it is important to let all the tubers cure, without touching each other, for several days in a warm, dry, well-ventilated room. In subsequent storage the yams should be placed

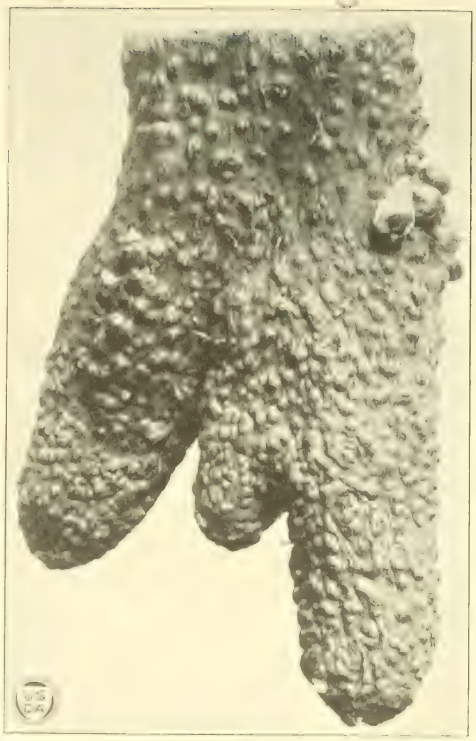


FIG. 1.—PIECE OF THE LOWER PART OF A YAM TUBER.

The warty surface is caused by infestation with the common root-knot nematode, or eelworm. The clusters of buds seen at the upper right and the left center are of normal development. (P27577FS.)

FIG. 2.—A SMALL TUBER (2½ POUNDS) OF A YAM, S. P. I. NO. 46801, GROWN IN CENTRAL FLORIDA.

Note the numerous prominent root scars. Larger tubers of this variety are frequently very irregular in form. (P27552FS.)

PREPARATION OF LAND IN TRINIDAD, WEST INDIES, FOR GROWING YAMS ON A LARGE SCALE BY THE TRENCH METHOD.

The trenches are to be filled and ridged with rotted manure, vegetable matter, and soil and the yams planted 15 inches apart. The stakes appearing in the photograph mark the position of young trees between which the yams are to be grown. (Photographed by F. W. Urich, Trinidad Department of Agriculture.)

FIG. 1.—VIEW OF AN EIGHTH-ACRE PATCH OF YAMS STAKED WITH BAMBOO. GROWN BY H. D. COLLETTE, NEAR CRESCENT CITY, FLA.

(P27188FS.)

FIG. 2.—YAMS TRAINED ON SINGLE-WIRE TRELLISES AT THE UNITED STATES PLANT INTRODUCTION GARDEN, BROOKSVILLE, FLA.

Bamboo stakes, untrimmed, are placed at each plant to conduct the vines up to the single horizontal wire at a height of about 5 feet. Posts the size of small fence posts are set about 20 feet apart. (P26656FS.)

VIEW IN A 4-ACRE FIELD OF YAMS (DIOSCOREA ALATA L.) GROWN WITHOUT TRELLISES BY O. P. WERNICKE, BROOKSVILLE, FLA.

(P27186FS.)

FIG. 1.—YAM VINES (DIOSCOREA ALATA L.) FORMING AN ATTRACTIVE SCREEN AND SHADE FOR A PORCH.

The vines may be trained in any desired way. (P27155FS.)

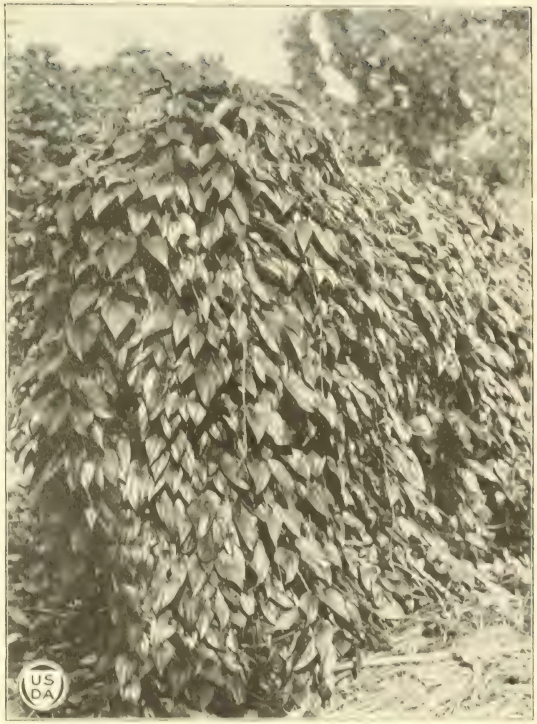


FIG. 2.—VINES OF THE GUAM YAM, DAGO HAYA.

Growth on a trellis at the Plant Introduction Garden, Miami, Fla. The tubers of this variety of the greater yam have a purple layer beneath the skin, and the flesh, often partly tinged with purple, darkens somewhat when cooked, but is of good flavor. (P26619FS.)

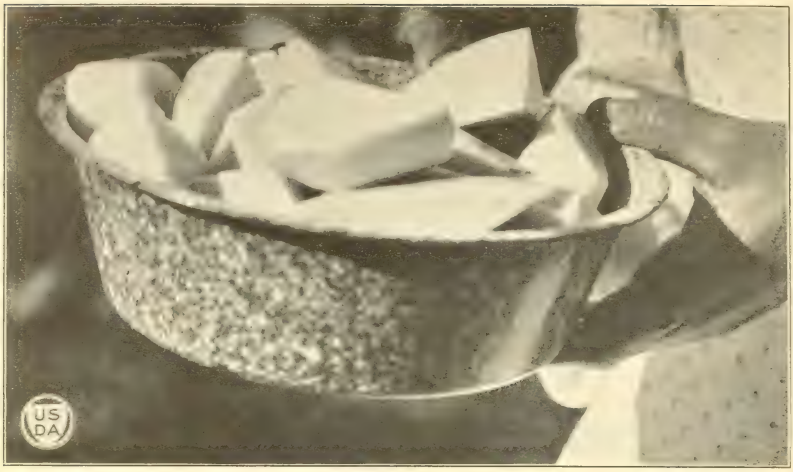


FIG. 1.—YAMS PARED AND CUT INTO PIECES PREPARATORY TO BOILING.

(P24655FS.)

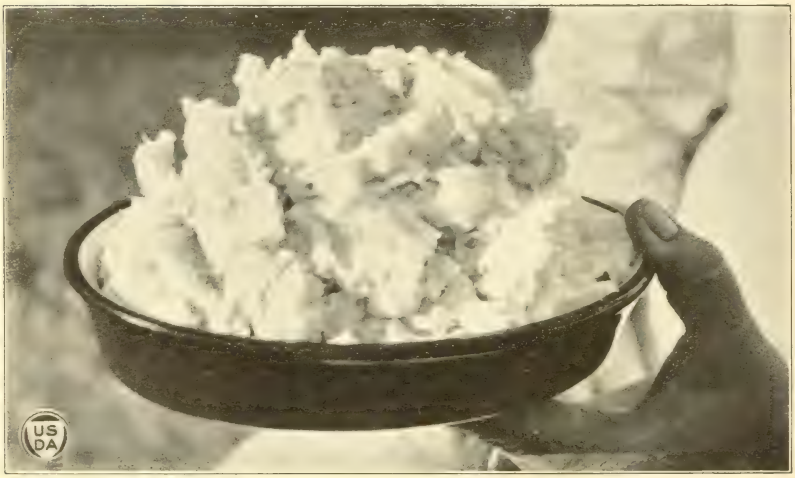


FIG. 2.—MASHED YAM, READY TO SERVE.

This dish is prepared in the same manner as mashed potato, but for the best results the beating after mashing should be very thorough; some yams, like this one, are sufficiently moist after boiling and mashing not to require the addition of milk for beating. (P24658FS.)

on slat shelves or in trays with slat bottoms. The best results have been obtained by having the tubers only one layer deep. Good ventilation, day and night, is essential to the successful storage of yams. The most favorable storage temperature after proper curing is between 55° and 60° F. Temperature is of secondary importance, however, and except when it falls to near the freezing point may be disregarded in favor of free ventilation. Under the conditions described, varieties of the greater yam have kept perfectly for several months at the Brooksville Plant Introduction Garden.

SHIPPING.

Yams for shipment should be packed in well-ventilated barrels or crates, with straw or similar material around each tuber to prevent bruising. When very cold weather is likely to be encountered the ventilation should be somewhat reduced. The less the ventilation to be given, however, the greater the need for the thorough curing of the yams previous to shipping. It is exceedingly important to avoid including in a container any tuber having a fresh bruise or other injury. Burlap covers for barrels, if strong and securely held under the top hoop, are quite sufficient in all ordinary shipments and have the advantage over solid heads of permitting better ventilation.

Because of the value of the yam crowns for propagation and the fact that they are discarded in the preparation of the tubers for the table, it will often pay the grower to cut off the crowns and store them until planting time. It is important, however, that the yams be well cured before they are cut. The cut surfaces should always be dried at once in sunlight, in order to reduce the chances of decay both of the main tuber and the crown. Dusting these surfaces with air-slaked lime or with fine wood ashes before drying is practiced by some yam growers in the Tropics, and the use of lime has been tried with some success on a small scale in Florida.

Occasionally yam tubers are too much lobed or branched to make it practicable to ship them entire. The market is not unaccustomed to cut tubers, however, and many of these irregular ones can be cut into pieces and shipped satisfactorily provided the yams are well cured and the raw surfaces properly dried or otherwise treated to prevent decay in transit. Growers should have an understanding beforehand with buyers of yams if they contemplate shipping yams with crowns removed or the tubers otherwise divided, in order to avoid possible dissatisfaction.

INSECT AND FUNGOUS ENEMIES.

No fungous disease, other than some of the common storage rots, has as yet made its appearance among true yams grown in the South, nor have any injurious insects been observed to attack the crop. However, as was stated in the beginning of this paper, yams in other countries are subject to attack from certain insect pests of the sweet potato, one of which, a sweet-potato weevil (*Cylas formicarius* Fab.), is already present in many sweet-potato localities in the South. The larvæ of these insects feed on the inside of the yam tubers and destroy them or ruin them for use. For a full discussion of the sweet-potato weevil, including suggestions for combating it, persons interested are referred to Farmers' Bulletin No. 1020.

Another pest to which yams are subject is the common root-knot nematode or eelworm (*Heterodera radicicola*). The injurious effects of root-knot are somewhat less marked than with the dasheen and some other crops, but severely infested yam tubers become warty and rough in appearance (Pl. V, Fig. 1) and consequently less desirable either for home use or for market. Seed yams affected with root-knot should be treated while dormant with hot water (122° F.) for 40 minutes, in order not only to give the young plants a better chance if the soil is already infested, but also to avoid the possibility of introducing this injurious plant parasite into ground previously free from it.

VARIETIES OF THE GREATER YAM.

As stated elsewhere, there are many varieties of the greater yam throughout the tropical world; but only those that at this time appear to have especial interest for southern growers will be considered here. Since the names of the varieties most widely tested in the South are uncertain, these varieties with a single exception will be designated by their seed and plant introduction (S. P. I.) numbers only. Limited quantities of these, whenever available, will be furnished by the Bureau of Plant Industry to persons in suitable localities who desire to experiment with them. Other varieties and other species are under test, and when definite information concerning them is available it is hoped to make it the subject of another publication.

S. P. I. NO. 37943.

The history of this unnamed variety, as far as it is known, has been given on page 4. The tuber is white fleshed and without pronounced coloration in the inner skin. The vine is prominently 4-angled and winged, and the leaf is rather long, heart-shaped, and dark green in color. The tubers are usually of medium to large size—up to 15 pounds in weight—and are of very good quality, though not equal to some of the varieties tested which have been recently introduced direct from the West Indies. For some time after it is harvested No. 37943 generally contains a little more moisture than is desirable.

As stated in the quotation from Mr. DeHoff's letter concerning this variety it does fairly well in rather light sandy soils, but increased yields are obtained in rich soils. In drained muck soil in the Florida Everglades in 1921 small smooth tubers were produced by this variety. The small size may have been due to the smallness of the tubers planted, however. While this variety is not a favorite on the market, it sells readily in the absence of better ones.

S. P. I. NO. 47001.

Yam No. 47001 (Pl. IV, Fig. 2), obtained by the Department of Agriculture more than 15 years ago from a grower at Lemon City, Fla., is similar to No. 37943 in vine, leaf, and tuber characters, except that the flesh of the former variety is still more moist and has less flavor. Chemical analysis indicates the starch content to be less than 14 per cent. The variety appears to be one of several which are classed under the general name Agua (water) yam in Porto Rico. The vine is more tender and brittle than that of the preceding variety, and seldom bears aerial tubers. The variety does

not do well in very light sandy soils, but in hammock lands and in properly drained muck lands single tubers up to about 12 pounds have been produced. This is not a good market yam, but it finds a ready sale when the yam market is unsupplied with the more popular sorts.

S. P. I. NO. 46801.

This yam was obtained by the Department of Agriculture in 1918 from Charles T. Simpson, of Littleriver, Fla., on whose place it had been growing for many years. Its previous history is unknown. The vine is usually somewhat obscurely 4-angled and wingless and is tougher than the vines of either of the preceding varieties. The leaves of all three are practically identical in form. The vine of No. 46801 often bears aerial tubers rather freely in the axils of the leaves, especially when the vines lie on the ground.

The underground tubers are white fleshed, and although not so fine grained as those of many varieties they are of good flavor; they are drier than those of most other varieties, analysis showing a content of 23 per cent of starch and 3 per cent of protein. In appearance the tubers are rather rough (Pl. V, Fig. 2) and often ill shaped and when dug are covered with fibrous roots. The variety does well on hammock land and on drained muck. On the former type of land single tubers have reached a weight of 21 pounds and on the latter 15 pounds in the first season's trials. Tubers of this variety which are of reasonably good shape find ready sale on the market.

An unlabeled collection of named varieties of the greater yam

THREE YAMS FROM TRINIDAD.

was received in 1918 from Trinidad. It included such varieties as Lisbon, Hunt, Bottle-Necked Lisbon, and Antigua White. Three of the varieties—the names of which can not as yet be determined—have been separated, and as they have proved to be of excellent quality they are being propagated and disseminated under S. P. I. Nos. 47263, 49825, and 54983, respectively. The vine and leaf characters of these varieties are not readily distinguishable. The vines are 4-angled and somewhat indistinctly winged. The leaves are long heart-shaped, as in the preceding varieties. Aerial tubers are rarely produced. Brief descriptions of the underground tubers of these three yams follow:

S. P. I. No. 47263.—This yam is white fleshed, becoming slightly grayish when cooked. It is mealy, moderately dry, and rich in flavor. Tubers up to 7 pounds in weight have been produced on hammock land in central Florida. Former importers of yams from the West Indies speak highly of this yam for market purposes.

S. P. I. No. 49825.—A yam of excellent quality, the flesh of which remains perfectly white when cooked. The tubers grown in Florida thus far have been rather small, but this is believed to be due to unfavorable circumstances which can be avoided. On account of the whiteness of this yam when cooked and of its high quality it will be a favorite wherever known.

S. P. I. No. 54983.—The tubers of this variety as raised in Florida are club shaped to cylindrical. Thus far the weight of individual tubers has not much exceeded a pound, but improved cultural conditions will doubtless increase this weight very materially. The flesh of the cooked tuber is perfectly white, mealy, and of very delicate flavor.

S. P. I. NO. 53475.

This yam was obtained from J. B. Brown, of Sebring, Fla., who brought it from Panama about 1914. The vine is 4-angled and dis-

tinctly winged, and the leaves are the same as those of the varieties previously mentioned. Aerial tubers are borne freely in some years and sparingly in others. The tubers are white fleshed, and the underground ones are large and of very good table quality.

In the season of 1920 Mr. Brown grew a much-branched tuber weighing 63 pounds, of which previous mention has been made. A large piece of tuber was planted in this instance, the plant received an abundance of water, and the growing season was longer than usual. In 1921 under ordinary field conditions tubers weighing up to 8 pounds each were grown at the Brooksville Plant Introduction Garden.

GUAM, OR DAGO HAYA, S. P. I. NO. 39705.

The Guam yam (Pl. IX, Fig. 2), or Dago Haya (signifying southern, or native, yam), was received in 1914 from Guam through Dr. W. E. Safford, of the Bureau of Plant Industry. The variety is said to be a favorite in Guam. It is very different from any of the other varieties of *Dioscorea alata* previously described here. Both ends of the petiole, or leafstalk, are strongly colored with reddish maroon. This feature is very characteristic and furnishes an easy means of distinguishing the growing plants of this type from those of any of the varieties described on earlier pages. The vine is 4-angled, with very narrow maroon wings at the angles. The leaf is similar in shape to that of the other varieties mentioned, but is of a slightly lighter shade of green. Aerial tubers are seldom produced.

The tubers sometimes grow to a considerable weight, as much as 28 pounds in rich sandy loam. The behavior of the variety in muck has been less satisfactory. In either type of soil large tubers are often very rough and of irregular shape and therefore are generally undesirable. The inner skin of the Guam yam is deep purple, and the white flesh beneath it is frequently tinged irregularly with purple. When cooked, the flesh usually becomes distinctly grayish and is often very mucilaginous; it is of rich flavor, however, and on this account is preferred by some persons to many of the whiter varieties. The darkening of this yam when cooked and the irregular form of tuber detract from its market value, notwithstanding its excellence of flavor.

S. P. I. NO. 46768.

This yam is practically identical in vine and leaf characters with the Guam variety (S. P. I. No. 39705), though the maroon color on the petioles is not always so pronounced. There are two strains of the variety. In one the tubers are apparently identical with the Guam yam, while in the other the purple layer in the skin is more sharply defined and much thinner. In the latter strain, if the purple is all pared away before cooking the flesh remains white; this strain is usually more mealy than the other, but it often has slightly less flavor.

PURPLE CEYLON, S. P. I. NO. 54900.

The Purple Ceylon yam, obtained from the Porto Rico Agricultural Experiment Station at Mayaguez, is distinguished by the production of tubers usually somewhat spherical in form and with deep-purple flesh. The rich color is retained in cooking, and the quality of the yam is excellent. This variety was secured by the

Porto Rico station from Ceylon in 1908. Recently a single tuber of what is apparently the same variety from India was turned over to the Office of Foreign Seed and Plant Introduction of the Bureau of Plant Industry. The donor stated that the variety is known in India as King of Yams. The name suggests the esteem in which this yam is held there. Under the name Purple Ceylon it appears to be regarded quite as highly in Porto Rico. While this yam is as yet only under preliminary test in Florida, its excellent quality and its popularity elsewhere warrant its mention at this time. It does not appear to yield an especially heavy crop, but under experimental conditions in Porto Rico it averaged nearly 5 pounds per plant.[11] The starch content of the fresh tuber is reported to be about 20 per cent.

PREPARATION OF YAMS FOR THE TABLE.

Just as tropical yams in general are comparable with the potato in food qualities, so they are prepared in the various ways in which potatoes are used. Like potatoes, the varieties of yams differ in quality, and the same variety, by gradual loss of moisture, changes slightly after being dug. Thus, some varieties are excellent when baked immediately after digging, while for others this method may not be wholly satisfactory until later. Some yams may be boiled in the skin, while others require paring beforehand because of some color or other quality in the skin that would affect the appearance or flavor of the cooked vegetable. It is usually better to pare all yams that are to be boiled.

Yams too large for use at one cooking may be used a piece at a time. The only consideration is that the part remaining each time shall be kept in a dry place, so that the cut surface will dry quickly and molding thus be prevented.

The time required for cooking most yams is a little less than for potatoes of equal size. The following are a few of the methods that have been found especially satisfactory for preparing yams. Recognizing the similarity of this vegetable to the potato, housewives and others interested will readily devise other methods if additional ones are desired.

BAKED YAM.

Clean the yam with a brush, removing any roots which may still adhere, and rinse in water. If the tuber is too large for use at one time or for baking entire it may be cut as desired and the piece or pieces handled as above. Bake in a moderate oven, only until tender; test with a fork. Serve hot with salt and butter.

BOILED YAMS.

While some of the yams may be boiled in the skin if desired, it is best first to pare them and if large cut them into pieces (Pl. X, Fig. 1). A good method is to cut the yam crosswise into slices an inch thick and then pare; these slices if too large may be cut into smaller pieces. Paring dry is recommended, for water makes yams slippery and therefore hard to handle. If water is used, however, a cut lemon or lime rubbed or squeezed over the pared surface of the yam will make it less slippery. After washing or soaking, place in

[11] Kinman, C. F. Yam culture in Porto Rico. Porto Rico Agr. Exp. Sta. Bul. 27, p. 17. 1921.

salted boiling water, boil gently (to prevent sticking to bottom of vessel) until tender, and drain. Yams usually cook more quickly than potatoes, and they sometimes go to pieces if boiled too long. The boiled yam may be served plain or with butter and other seasoning added. It may also be further prepared according to one of the following recipes or by other desired methods.

MASHED YAM.

Mashed yam is prepared like mashed potato. Starting with the yam boiled in accordance with the directions in the preceding recipe, mash, season with butter, and beat until light (Pl. X, Fig. 2). It is important to keep the yam hot while mashing; if it is too dry for beating add milk (preferably warm) as required. Mashed yam usually becomes very firm upon standing for even a few minutes and therefore should be served promptly. Properly prepared and served promptly, this is perhaps the most generally satisfactory of all yam dishes.

YAM SALAD.

The salad is prepared from the boiled yam while still warm, in the same manner as potato salad. Some yams are better suited than others to this use, but practically all of the white-fleshed ones are satisfactory.

FRIED YAM.

(1) Warm or cold boiled yam may be used very satisfactorily for frying. If somewhat dry it is best to cut the yam into slices about an inch thick and fry (sauté) quickly in a covered frying pan. With moister yams the thick slices and the covering of the frying pan are not so necessary.

(2) Yam cakes molded from mashed yam and fried are very good.

(3) Cakes molded from warm mashed yam without the addition of any milk but seasoned with butter are especially pleasing when fried. The hands should be moistened with water while the cakes are being molded, and if the yam is still too dry to handle a very little of the water used in boiling may be returned to it. It is desirable, however, not to have the cakes more moist than is necessary for molding them. Containing no milk, they often can be kept for a day or two without detriment before frying.

(4) Raw yam may be sliced about half an inch thick, dipped in bread crumbs, flour, or egg, and fried.

(5) French-fried yam is also excellent. With the drier yams, however, care should be taken not to fry them longer than actually necessary.

YAMS ROASTED WITH MEAT.

Yams cooked in this way are especially delicious. They are pared, cut into pieces of suitable size, and placed like potatoes in the pan with the meat, either at the beginning or later, depending upon the relative size of the roast and the pieces of yam.

SUMMARY.

The true yams belong to a large genus—Dioscorea—of tuber-bearing plants, many species of which are edible and a few of great economic importance to millions of people. The true yams are entirely distinct from the sweet potato, to certain moist varieties of

which the name yam has been erroneously applied. The plants of the yams are climbing, twining vines. Nearly all of them bear their main crop of tubers in the ground, but some produce aerial tubers in the axils of the leaves, and a few bear aerial tubers almost exclusively.

Yams are much like the potato in composition and food value, and many of them when prepared for the table are equal or superior to it in appearance and taste. They are baked, boiled, fried, and cooked in the various other ways in which potatoes are used. Yams mature in the late fall or early winter and should be grown widely for home use and local markets in the South Atlantic and Gulf regions to supplement the fall potato crop.

Of the several important edible species the greater yam (*Dioscorea alata* L.) is one of the most valuable and most widely distributed, and several varieties of it are now cultivated for home use or for market by a considerable number of people in Florida and near-by States. A market for home-grown yams has existed in New York among the West Indian population since 1918, when, in order to avoid the danger of introducing certain injurious insects, the further commercial importation of yams from the West Indies and elsewhere was prohibited.

A season of at least 8 to 10 months is required for the successful cultivation of yams as a crop, but the vines are ornamental and may be grown for porch decoration and similar uses even where the season is materially shorter.

The labor involved in properly preparing the land for planting yams and for the proper handling of the crop when grown makes the cost of production higher than that for other tuber crops, but on the other hand this vegetable commands a considerably higher price on the market. The great excellence of the best yams as food gives reason to believe that the crop will become the basis of an agricultural industry of importance in the South.

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Bureau of Plant Industry	WILLIAM A. TAYLOR, *Chief.*
Office of Foreign Seed and Plant Introduction	DAVID FAIRCHILD, *Agricultural Explorer in Charge.*

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